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National Occupational Analysis

Machinist

2013

CANADIAN STANDARD OF EXCELLENCE FOR SKILLED TRADES

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National Occupational Analysis

Machinist

2013

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FOREWORD

The Canadian Council of Directors of Apprenticeship (CCDA) recognizes this National Occupational Analysis (NOA) as the national standard for the occupation of Machinist.

Background

The first National Conference on Apprenticeship in Trades and Industries, held in Ottawa in 1952, recommended that the federal government be requested to cooperate with provincial and territorial apprenticeship committees and officials in preparing analyses of a number of skilled occupations. To this end, Employment and Social Development Canada (ESDC) sponsors a program, under the guidance of the CCDA, to develop a series of NOAs.

The NOAs have the following objectives:

- to describe and group the tasks performed by skilled workers;
- to identify which tasks are performed in every province and territory;
- to develop instruments for use in the preparation of Interprovincial Red Seal Examinations and curricula for training leading to the certification of skilled workers;
- to facilitate the mobility of apprentices and skilled workers in Canada; and,
- to supply employers, employees, associations, industries, training institutions and governments with analyses of occupations.

ACKNOWLEDGEMENTS

The CCDA and ESDC wish to express sincere appreciation for the contribution of the many tradespersons, industrial establishments, professional associations, labour organizations, provincial and territorial government departments and agencies, and all others who contributed to this publication.

Special acknowledgement is extended to the following representatives from the trade who attended a national workshop to develop the previous edition of this NOA in 2010.

Brian Dawe	Newfoundland and Labrador
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Terry Pederson	Saskatchewan
Greg Peltz	Ontario
Joseph Perruccio	International Association of Machinists and Aerospace Workers
Graham Peterson	Alberta
Jake Shaw	Prince Edward Island
George Wilander	British Columbia

This 2013 edition of the NOA was reviewed, updated and validated by industry representatives from across Canada to ensure that it continues to represent the skills and knowledge required in this trade. The coordinating, facilitating and processing of this analysis were undertaken by employees of the NOA development team of the Trades and Apprenticeship Division of ESDC. The host jurisdiction of Ontario also participated in the development of this NOA.

Comments or questions about National Occupational Analyses may be forwarded to:

Trades and Apprenticeship Division
Labour Market Integration Directorate
Employment and Social Development Canada
140 Promenade du Portage, Phase IV, 5th Floor
Gatineau, Quebec K1A 0J9
Email: redseal-sceaurouge@hrsdc-rhdcc.gc.ca

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To facilitate understanding of the occupation, the work performed by tradespersons is divided into the following categories:

Blocks	largest division within the analysis that is comprised of a distinct set of trade activities
Tasks	distinct actions that describe the activities within a block
Sub-Tasks	distinct actions that describe the activities within a task
Key Competencies	activities that a person should be able to do in order to be called 'competent' in the trade

The analysis also provides the following information:

Context	information to clarify the intent and meaning of tasks
Trends	changes identified that impact or will impact the trade including work practices, technological advances, and new materials and equipment
Related Components	list of products, items, materials and other elements relevant to the block
Tools and Equipment	categories of tools and equipment used to perform all tasks in the block; these tools and equipment are listed in Appendix A
Required Knowledge	the elements of knowledge that an individual must acquire to adequately perform a task

The appendices located at the end of the analysis are described as follows:

Appendix A — Tools and Equipment	non-exhaustive list of tools and equipment used in this trade
Appendix B — Glossary	definitions or explanations of selected technical terms used in the analysis
Appendix C — Acronyms	list of acronyms used in the analysis with their full name
Appendix D — Block and Task Weighting	the block and task percentages submitted by each jurisdiction, and the national averages of these percentages; these national averages determine the number of questions for each block and task in the Interprovincial exam
Appendix E — Pie Chart	graph which depicts the national percentages of exam questions assigned to blocks
Appendix F — Task Profile Chart	chart which outlines graphically the blocks, tasks and sub-tasks of this analysis

DEVELOPMENT AND VALIDATION OF ANALYSIS

Development of Analysis

A draft analysis is developed by a committee of industry experts in the field led by a team of facilitators from ESDC. This draft analysis breaks down all the tasks performed in the occupation and describes the knowledge and abilities required for a tradesperson to demonstrate competence in the trade.

Draft Review

The NOA development team then forwards a copy of the analysis and its translation to provincial and territorial authorities for a review of its content and structure. Their recommendations are assessed and incorporated into the analysis.

Validation and Weighting

The analysis is sent to all provinces and territories for validation and weighting. Participating jurisdictions consult with industry to validate and weight the document, examining the blocks, tasks and sub-tasks of the analysis as follows:

BLOCKS	Each jurisdiction assigns a percentage of questions to each block for an examination that would cover the entire trade.
TASKS	Each jurisdiction assigns a percentage of exam questions to each task within a block.
SUB-TASKS	Each jurisdiction indicates, with a YES or NO, whether or not each sub-task is performed by skilled workers within the occupation in its jurisdiction.

The results of this exercise are submitted to the NOA development team who then analyzes the data and incorporates it into the document. The NOA provides the individual jurisdictional validation results as well as the national averages of all responses. The national averages for block and task weighting guide the Interprovincial Red Seal Examination plan for the trade.

This method for the validation of the NOA also identifies common core sub-tasks across Canada for the occupation. If at least 70% of the responding jurisdictions perform a sub-task, it shall be considered common core. Interprovincial Red Seal Examinations are based on the common core sub-tasks identified through this validation process.

Definitions for Validation and Weighting

YES	sub-task performed by qualified workers in the occupation in a specific jurisdiction
NO	sub-task not performed by qualified workers in the occupation in a specific jurisdiction
NV	analysis Not Validated by a province/territory
ND	trade Not Designated in a province/territory
NOT COMMON CORE (NCC)	sub-task, task or block performed by less than 70% of responding jurisdictions; these will not be tested by the Interprovincial Red Seal Examination for the trade
NATIONAL AVERAGE %	average percentage of questions assigned to each block and task in Interprovincial Red Seal Examination for the trade

Provincial/Territorial Abbreviations

NL	Newfoundland and Labrador
NS	Nova Scotia
PE	Prince Edward Island
NB	New Brunswick
QC	Quebec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
NT	Northwest Territories
YT	Yukon Territory
NU	Nunavut

ANALYSIS

Safe working procedures and conditions, accident prevention, and the preservation of health are of primary importance to industry in Canada. These responsibilities are shared and require the joint efforts of government, employers and employees. It is imperative that all parties become aware of circumstances that may lead to injury or harm. Safe learning experiences and work environments can be created by controlling the variables and behaviours that may contribute to accidents or injury.

It is generally recognized that safety-conscious attitudes and work practices contribute to a healthy, safe and accident-free work environment.

It is imperative to apply and be familiar with the Occupational Health and Safety (OH&S) Acts and Workplace Hazardous Materials Information System (WHMIS) Regulations. As well, it is essential to determine workplace hazards and take measures to protect oneself, co-workers, the public and the environment.

Safety education is an integral part of training in all jurisdictions. As safety is an imperative part of all trades, it is assumed and therefore it is not included as a qualifier of any activities. However, the technical safety tasks and sub-tasks specific to the trade are included in this analysis.

SCOPE OF THE MACHINIST TRADE

"Machinist" is this trade's official Red Seal occupational title approved by the CCDA. This analysis covers tasks performed by machinists whose occupational title has been identified by some provinces and territories of Canada under the following names:

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
General Machinist						✓							
Machinist	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓

Fully qualified machinists possess the knowledge and abilities to set up and machine using conventional, portable and Computer Numerical Control (CNC) machines that cut or grind metal and other materials into products with precise dimensions. These machines include lathes, milling machines, saws, grinding machines, drilling machines, boring machines, line borers and portable milling machines.

Machinists work from drawings, specifications and their own measurements to calculate dimensions, tolerances and types of fit. Precise measurements are critical to machinists' work. They must be knowledgeable about the properties of metals and non-metallic materials.

Machinists may work in industries where machines are manufactured, repaired or used. These may include industries that manufacture machinery equipment, motor vehicle or aerospace parts. Machinists produce precision parts that are used in all aspects of manufacturing. They may also work in shipyards, rail yards, refineries, pulp and paper mills, mines, smelters, metal fabricating and repair shops. Shiftwork is common in some companies. Machinists tend to work indoors.

Safety is important at all times. There are risks of injury working with moving machine parts, sharp edges, flying debris and extreme temperatures from heated or chilled materials. Precautions are required while working with manufacturing chemicals and airborne irritants.

Key attributes for people entering this trade are: communication skills, mechanical aptitude, hand-eye coordination, manual dexterity, an ability to work independently and knowledge of mathematics and physics. The work often requires considerable standing and the handling of heavy objects. This analysis recognizes similarities or overlaps with the work of other tradespeople such as tool and die makers, mould makers, welders and industrial mechanics (millwrights).

Experienced machinists may move into supervisory positions. With additional training, they may transfer their skills to related occupations such as tool and die maker, mould maker, industrial mechanic (millwright) or CNC programmer.

OCCUPATIONAL OBSERVATIONS

Conventional machining skills continue to form the basis of the trade and are pre-requisite to being able to set up and program CNC machine-tools safely and efficiently.

Hybrid machines, which combine conventional and CNC features, continue to be part of the market.

Many advances in machine tool configuration and technology, in particular CNC, as well as advances in cutting tools and fluids have increased efficiency and accuracy.

ESSENTIAL SKILLS SUMMARY

Essential skills are needed for work, learning and life. They provide the foundation for learning all other skills and enable people to evolve with their jobs and adapt to workplace change.

Through extensive research, the Government of Canada and other national and international agencies have identified and validated nine essential skills. These skills are used in nearly every occupation and throughout daily life in different ways.

A series of CCDA-endorsed tools have been developed to support apprentices in their training and to be better prepared for a career in the trades. The tools can be used independently or with the assistance of a tradesperson, trainer, employer, teacher or mentor to:

- understand how essential skills are used in the trades;
- learn about individual essential skills strengths and areas for improvement; and
- improve essential skills and increase success in an apprenticeship program.

Tools are available online or for order at: http://www.hrsdc.gc.ca/eng/jobs/les/index.shtml.

The essential skills profile for the machinist trade indicates that the most important essential skills are **document use**, **numeracy** and **critical thinking**. Machinists attending the NOA workshop in 2010 also identified **reading** as a very important essential skill.

The application of these skills may be described throughout this document within the competency statements which support each subtask of the trade. The following are summaries of the requirements in each of the essential skills, taken from the essential skills profile.

A link to the complete essential skills profile can be found at www.red-seal.ca.

Reading
Machinists require strong reading skills to gather information from forms and labels. They also need to read longer texts such as notes, letters, process sheets, manuals (*Machinery's Handbook*), specifications, regulations, reports, data collection, books and charts.

Document Use
Document use is a significant essential skill for this trade. Machinists need to be able to refer to and interpret several types of documents such as inspection reports, work orders, charts, sketches and drawings. They also need to be able to enter information or create these documents.

Writing
Writing skills are used by machinists to record job procedures, write work-related requests, record tooling lists and setup sheets, and record lengthy work instructions and process sheets of machining jobs.

Oral Communication
Some tasks performed by machinists require oral communication skills, including exchanging technical information with co-workers, discussing work with supervisors, interacting with customers and instructing less-experienced machinists and apprentices.

Numeracy
Numeracy skills are very important in the everyday work of machinists. Machinists frequently calculate measurements and dimensions of raw materials and finished products to make sure they match specifications. They must calculate speeds and feeds for the machines that they operate. Layout of workpieces requires strong geometry and trigonometry skills.

Thinking Skills
Machinists must plan, make allowances and corrections, and determine the best sequence of work processes. They use problem solving skills to assess and adjust machining processes according to unforeseen circumstances. Machinists must make decisions and use critical thinking about the materials or tools to use for specific jobs. They may initiate design changes. They may be responsible for scheduling and delegating tasks to apprentices or junior machinists.

Working with Others
Much of machinists' work may be done independently such as interpreting, planning, producing and repairing parts. Machinists may work with other machinists to carry out new or complex tasks, or work on larger jobs. They may also work with engineering staff and computer programming staff.

Computer Use
Machinists use computers and computer-assisted design software in their work. They may use computers to access database information, reference electronic manuals and resources, communicate with others or perform Internet research.

Continuous Learning
Machinists are required to stay abreast of new technologies, products and trends in the machining industry.

BLOCK A — COMMON OCCUPATIONAL SKILLS

Context	This block describes the repetitive general skills for many tasks performed by a machinist that are common to several machine-tool applications.
Trends	Traceability is becoming more important in some industries such as manufacturing, oil and gas, aerospace and defence. Environmental protocol is increasingly stringent. Quality control and quality control documentation is becoming an integral part of the manufacturing process.
Related Components	Not applicable.
Tools and Equipment	See Appendix A.

Task 1 — Organizes work.

Required Knowledge

K 1	types of documentation such as work orders, technical data, reference manuals and quality control documentation
K 2	types of drawings
K 3	first and third angle projection
K 4	symbols such as surface finishes, scales and tolerances
K 5	machining operations
K 6	material characteristics such as composition, properties, application and machinability
K 7	time required to complete each operation
K 8	heat treatment required
K 9	WHMIS
K 10	federal and provincial/territorial safety regulations such as the *Occupational Health and Safety Act* (OHSA) and *Canada Labour Code Part II*
K 11	types and operation of fire extinguishing equipment
K 12	disposal and recycling procedures

K 13	work hazards such as those associated with the operation of hand and power tools, cutting, grinding and machining equipment
K 14	workplace housekeeping procedures and practices
K 15	absorbent materials
K 16	lock-out procedures
K 17	types of personal protective equipment (PPE) such as respiratory, hearing, eye and body protection
K 18	PPE and safety equipment operations
K 19	location of PPE and safety equipment
K 20	types of hoisting and lifting equipment such as jacks, chain hoists and overhead cranes
K 21	applications of hoisting, lifting and rigging procedures
K 22	limitations of hoisting, lifting and rigging equipment
K 23	hoisting, lifting and rigging equipment maintenance

Sub-task

A-1.01 Interprets documentation.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.01.01	determine information such as number of parts to make, material to be used and machines to be used
A-1.01.02	check drawing for material and processing specifications, dimensioning, machining allowances, standard and geometric dimensioning tolerances (GDT) and conflicting information
A-1.01.03	visualize finished product by analyzing dimensions and drawings
A-1.01.04	use process sheet to determine order of operations
A-1.01.05	locate information in reference materials such as *Machinery's Handbook*
A-1.01.06	perform mathematical calculations to augment information provided by documentation

Sub-task

A-1.02 Plans sequence of operations.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.02.01	determine factors such as rough sizes of parts, finish allowances and tolerances required
A-1.02.02	analyze material properties such as material dimensions and composition in order to determine work holding strategy, rough machining operations, finish machining operations and heat treating processes
A-1.02.03	recognize limitations of equipment or machine inventory to perform a task and recommend which work needs to be sent out for specialized operations
A-1.02.04	visualize process from start to finish in order to make provisions for future machining processes

Sub-task

A-1.03 Maintains safe work environment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.03.01	comply with lock-out and tag-out procedures
A-1.03.02	recognize worksite hazards such as slippery floors, tangled air lines and power cords, and hazardous fumes
A-1.03.03	recognize machine hazards such as hot or irregular chip formation, insecurely mounted workpiece, defective equipment and contaminated coolant
A-1.03.04	stack and store parts and materials in designated locations and formations
A-1.03.05	follow specified safety procedures such as using safety glasses and safety shoes and following evacuation procedures
A-1.03.06	maintain a clean and tidy work area to avoid injuries to self and others
A-1.03.07	coordinate tasks with other workers to avoid injuries to self and others

A-1.03.08 handle hazardous materials in accordance with WHMIS procedures such as disposal, labelling and use of PPE

A-1.03.09 participate in safety meetings and discussions

Sub-task

A-1.04 Uses personal protective equipment (PPE) and safety equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.04.01 identify site hazards and regulations requiring the use of PPE and safety equipment

A-1.04.02 maintain and store PPE and safety equipment

A-1.04.03 apply local, provincial and national safety regulations such as WHMIS

A-1.04.04 identify PPE damage such as excessively worn boots and cracked safety glasses or face shields

A-1.04.05 recognize CSA-approved PPE and applicable safety equipment such as fire extinguishers

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Sub-task

A-1.05 Uses hoisting, lifting and rigging equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-1.05.01 determine approximate weight of lift to stay within capacity of available equipment

A-1.05.02 recognize shop and regulatory limitations and determine what rigging and hoisting operations need to be done by qualified personnel

A-1.05.03 inspect hoisting, lifting and rigging equipment for defects and expiration dates

A-1.05.04 store equipment in clean and dry locations

Task 2 — Processes workpiece material.

Required Knowledge

K 1	types and grades of material
K 2	material characteristics such as composition, properties, application and machinability
K 3	identification markings such as ASME systems, ANSI systems, colour codes and number systems
K 4	material measurements
K 5	layout procedures
K 6	layout media such as dyes, paint, markers and coating
K 7	marking procedures such as etching, engraving, colour coding and stamping
K 8	metallurgy
K 9	types of heat treatment processes such as flame hardening, hardening, normalizing, annealing and stress relieving
K 10	types of heat treatment equipment such as torches and ovens
K 11	tempering colours
K 12	types of material defects such as bends, cracks and size deviations
K 13	deburring techniques
K 14	inspection procedures and techniques such as incoming, in-process and final
K 15	types of layout and inspection equipment such as micrometers, dividers, height gauges, calipers, protractors and hardness testers
K 16	required dimensions and dimensional accuracy
K 17	geometric dimensioning and tolerancing
K 18	sketching techniques
K 19	types of orthographic projection such as first angle and third angle
K 20	dimensioning practices
K 21	inspection techniques used to determine or find cracks in workpiece

Sub-task

A-2.01 Selects workpiece material.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.01.01	determine type of material used in original part when producing a replacement part using techniques such as hardness testing and examining mechanical properties
A-2.01.02	determine size, shape and mechanical properties such as machinability, tensile strength, wear resistance and stress
A-2.01.03	identify stock material using identifying characteristics such as colour coding, surface finish and stamps
A-2.01.04	inspect material for defects such as bends, cracks and size deviations

Sub-task

A-2.02 Performs layout.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.02.01	determine shape and requirements of layout by reading engineering drawing and specifications
A-2.02.02	select and use layout tools and instruments such as surface plates, layout die, scribers, height gauges and prick punches
A-2.02.03	mark workpiece according to drawing specifications
A-2.02.04	verify layout by using measuring tools such as calipers, dividers and steel rules

Sub-task

A-2.03 Marks workpiece for identification.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.03.01	follow coding system used in shop to maintain organization of inventory
A-2.03.02	etch or stamp required information such as heat numbers, parts numbers and composition

Sub-task

A-2.04 Performs basic heat treatment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.04.01	select and use equipment and supplies for heat treatment such as torches, oven and quenching media
A-2.04.02	identify required heat treating such as annealing, normalizing, tempering, heating and quenching
A-2.04.03	select and use material handling equipment for heat treatment such as tongs, protective gloves, face shield and aprons
A-2.04.04	perform heat treatment techniques such as annealing, normalizing, flame hardening, tempering, heating and quenching
A-2.04.05	determine required temperature for each heat treatment process using reference material such as *Machinery's Handbook*
A-2.04.06	interpret tempering colours and temperatures of metals
A-2.04.07	verify required level of hardness

Sub-task

A-2.05 **Tests workpiece materials.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.05.01	perform hardness tests such as file test, Rockwell and Brinell
A-2.05.02	perform non-destructive testing such as dye penetrant tests
A-2.05.03	identify general material type
A-2.05.04	interpret test results and compare to required tolerances

Sub-task

A-2.06 **Deburrs workpiece.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.06.01	identify features to be deburred
A-2.06.02	select and use hand and power tools for deburring such as files, deburring tools, die grinders and abrasive materials
A-2.06.03	mask surfaces to protect from damage through deburring process

Sub-task

A-2.07 **Sketches parts.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-2.07.01	draw basic outline of component features to an approximate proportion
A-2.07.02	verify workpiece dimensions using measuring tools such as straight edge, micrometers and calipers
A-2.07.03	transfer dimensions to sketch

Task 3 Maintains machines and tooling.

Required Knowledge

K 1	manufacturers' specifications
K 2	cleaning techniques and requirements
K 3	cleaning solvents
K 4	cleaning equipment
K 5	machine lock-out procedures
K 6	sensitive components such as digital readout and programmable logic controller (PLC)
K 7	types of lubricants
K 8	lubrication points
K 9	maintenance schedule
K 10	tool geometry such as rake angles, relief angles and chip breakers
K 11	types of tool sharpening equipment such as tool and cutter, pedestal and drill grinders
K 12	types of cutting fluids and application techniques
K 13	types of coolants and application techniques
K 14	machine operations and components
K 15	types of alignment equipment such as dial indicator, precision level, square and laser

K 16	equipment and procedures used in calibration of inspection equipment according to jurisdictional requirements
K 17	truing and dressing wheel procedures on pedestal grinders

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Sub-task

A-3.01 Cleans machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.01.01	refer to manufacturers' documentation for machine-specific requirements
A-3.01.02	identify sensitive components on machinery
A-3.01.03	determine cleaning agents to be used
A-3.01.04	apply cleaning agents
A-3.01.05	remove residue
A-3.01.06	clean or replace filters and screens
A-3.01.07	ensure compliance with maintenance schedule

Sub-task

A-3.02 Lubricates machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.02.01	refer to manufacturers' documentation for machine-specific requirements
A-3.02.02	identify sensitive components on machinery
A-3.02.03	identify and select lubricants according to machine requirements
A-3.02.04	apply lubricants to specific locations and required levels
A-3.02.05	ensure used lubricants are disposed of according to environmental protocol
A-3.02.06	ensure compliance with maintenance schedule

Sub-task

A-3.03 Sharpens tooling.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.03.01	refer to manufacturers' documentation for tool-specific requirements
A-3.03.02	identify incorrect cutting geometry
A-3.03.03	dress grinding wheel using tools such as dressing stick (stone) and diamond dressing tool to restore cutting properties
A-3.03.04	grind cutting edge of tools to establish required tool geometry such as thinned web and chip breaker to ensure optimum material removal and finish

Sub-task

A-3.04 Applies cutting fluids and coolants.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.04.01	refer to manufacturers' documentation for machine-specific requirements
A-3.04.02	mix cutting fluids and coolants to required ratio
A-3.04.03	add cutting fluids and coolants to machine reservoirs to required levels
A-3.04.04	check coolant concentration using refractometer, test strips and other means
A-3.04.05	utilize cutting fluids and coolants for cutting operations as required
A-3.04.06	ensure compliance with maintenance schedule

Sub-task

A-3.05 Troubleshoots equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.05.01	refer to manufacturers' documentation for machine-specific requirements and parameters
A-3.05.02	visually inspect equipment for potential problems
A-3.05.03	identify and isolate problems
A-3.05.04	take remedial action

Sub-task

A-3.06 Maintains machine alignment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.06.01	refer to manufacturers' documentation for machine-specific requirements
A-3.06.02	determine when and where alignment is required
A-3.06.03	identify and select tools and equipment such as dial indicators, precision levels and squares
A-3.06.04	adjust machine to achieve required alignment
A-3.06.05	ensure compliance with maintenance schedule

Sub-task

A-3.07 Maintains inspection equipment.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

A-3.07.01	refer to manufacturers' documentation for equipment-specific requirements
A-3.07.02	clean equipment prior to calibration
A-3.07.03	calibrate inspection equipment in temperature-controlled environment to recognized standards
A-3.07.04	wipe surface plates using required cleaning agents
A-3.07.05	ensure compliance with maintenance schedule

BLOCK B — BENCH WORK

Context	Machinists use hand tools and handheld power tools at a bench. These activities include sawing, drilling, tapping, assembly and disassembly. Benchwork is critical for fully qualified machinists.
Trends	No trends identified.
Related Components	Not applicable.
Tools and Equipment	See Appendix A.

Task 4 — Performs hand processes.

Required Knowledge

K 1	types of files
K 2	tooth pitch and set of saw blades
K 3	sawing techniques
K 4	holding techniques
K 5	types of tooling such as drills, reamers and hones
K 6	taps such as taper, plug, bottom, stagger-tooth and pipe
K 7	thread, pitch and form
K 8	thread cutting techniques
K 9	types of inserts such as single coil, double coil, key insert, tabbed insert and thread repair insert
K 10	broach forms such as keyseats, hexagon and square hole
K 11	types and sizes of keys
K 12	types of presses such as arbour and hydraulic
K 13	supporting techniques for presses
K 14	heating equipment such as oxy-fuel torches
K 15	lapping and honing techniques
K 16	polishing and blending techniques
K 17	abrasives

K 18	handheld power tools such as portable drill
K 19	portable saws such as abrasive cut off, cold cut and hand held band saw

---

Sub-task

B-4.01 Files workpiece.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.01.01	select files such as single cut, double cut and needle files along with handle for application
B-4.01.02	select work holding devices such as vise, soft jaws, parallel clamp and c-clamp
B-4.01.03	set up workpiece in work holding device to protect material and operator
B-4.01.04	perform filing technique to optimize material removal
B-4.01.05	measure workpiece throughout the process to make finish adjustments
B-4.01.06	identify process problems such as file pinning, rounded edges and damage to cutting tool
B-4.01.07	use file card to remove debris from file and restore the cutting ability of the file
B-4.01.08	verify workpiece meets specifications using inspection equipment such as precision square, combination square and calipers

---

Sub-task

B-4.02 Saws workpiece.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.02.01	select blade and pitch for application
B-4.02.02	install and tension blade in the frame
B-4.02.03	select work holding devices such as vise, soft jaws, parallel clamp and c-clamp
B-4.02.04	set up workpiece in work holding device to protect material and operator

B-4.02.05	perform sawing technique to optimize material removal
B-4.02.06	identify process problems such as dull blade, worn set and broken teeth
B-4.02.07	verify workpiece meets specifications using inspection equipment such as precision square, combination square and steel rule

---

Sub-task

B-4.03 Performs hole-making operations.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.03.01	select prick punch and centre punch according to hole size
B-4.03.02	punch layout to determine drilling position
B-4.03.03	select centre drill for application
B-4.03.04	centre drill the workpiece
B-4.03.05	select drill(s) for application
B-4.03.06	drill the workpiece
B-4.03.07	select reamer for application
B-4.03.08	ream workpiece
B-4.03.09	measure and check feature throughout the process to make finish adjustments
B-4.03.10	identify process problems such as drill wandering, oversized holes and damage to cutting tool
B-4.03.11	verify feature meets specifications using inspection equipment such as precision square, combination square, calipers and gauges

Sub-task

B-4.04 Performs threading operations.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.04.01	select taps or dies according to specifications
B-4.04.02	select tap handle or die stock
B-4.04.03	select work holding devices such as vise, soft jaws, parallel clamp and c-clamp
B-4.04.04	set up workpiece in work holding device to protect material and operator
B-4.04.05	tap or thread workpiece
B-4.04.06	measure and check feature throughout the process to make finish adjustments
B-4.04.07	identify process problems such as damaged threads, broken taps and cross threading
B-4.04.08	verify feature meets specifications using inspection equipment such as thread gauges, ring gauges and sample piece
B-4.04.09	extract broken taps

Sub-task

B-4.05 Installs thread inserts.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.05.01	clean hole to ensure no contamination
B-4.05.02	select type of thread insert according to size, length and application
B-4.05.03	select installation tool according to size
B-4.05.04	select work holding devices such as vise, soft jaws, parallel clamp and c-clamp
B-4.05.05	set up workpiece in work holding device to protect material and operator

B-4.05.06	perform insertion technique to strengthen or repair the thread
B-4.05.07	verify feature meets specifications using equipment such as thread gauges and sample piece

---

Sub-task

B-4.06 Broaches workpiece.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.06.01	select type of broach, bushing and shims according to specifications
B-4.06.02	perform broaching technique
B-4.06.03	measure feature throughout the process to make finish adjustments
B-4.06.04	identify process problems such as jamming, breaking broach, or tapered cuts
B-4.06.05	verify feature meets specifications using inspection equipment such as sample piece, go-no-go gauges and calipers

---

Sub-task

B-4.07 Performs pressing operations.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.07.01	select press such as arbour and hydraulic
B-4.07.02	select work holding devices such as V-blocks, table blocks and collar
B-4.07.03	set up workpiece in work holding device to protect material and operator
B-4.07.04	set work table height on hydraulic press to accommodate workpiece
B-4.07.05	perform pressing techniques such as using expansion/contraction and applying required adhesive or lubricant
B-4.07.06	measure and check feature throughout the process to make adjustments
B-4.07.07	identify process problems such as misalignment and galling

B-4.07.08	identify interference tolerances for specific application
B-4.07.09	verify feature meets specifications using inspection equipment such as precision square, depth gauge and straight edge

---

Sub-task

B-4.08 Bends workpiece.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.08.01	select heating equipment such as oxy-acetylene and propane torches according to workpiece
B-4.08.02	set up heating equipment
B-4.08.03	select work holding devices such as vise, tongs and anvil
B-4.08.04	set up workpiece in work holding device to protect material and operator
B-4.08.05	determine bend allowance
B-4.08.06	perform heating technique to make workpiece malleable
B-4.08.07	measure and check feature throughout the process to make adjustments
B-4.08.08	identify process problems such as excessive heat and bending force
B-4.08.09	verify feature meets specifications using inspection equipment such as precision square, combination square and calipers

---

Sub-task

B-4.09 Finishes workpiece.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-4.09.01	select finishing process such as lapping, honing, deburring, polishing and scraping according to job specifications
B-4.09.02	clean the workpiece
B-4.09.03	select abrasives such as hones, stones and lapping compounds
B-4.09.04	select required work holding devices such as vise, soft jaws, parallel clamp and c-clamp

B-4.09.05	set up workpiece in work holding device to protect material and operator
B-4.09.06	perform finishing technique to achieve required finish
B-4.09.07	use comparators and measure workpiece throughout the process to make finish adjustments
B-4.09.08	identify process problems such as scratching, rounded edges and damage to hone
B-4.09.09	clean workpiece to remove debris
B-4.09.10	verify workpiece meets specifications using inspection equipment such as precision square, calipers, surface finish comparator and micrometers
B-4.09.11	protect finished workpiece using material such as rust inhibitor, paper and crating

Task 5 Refurbishes components.

Required Knowledge

K 1	fits, clearances and tolerances
K 2	original specifications and application of components
K 3	repair techniques
K 4	retention techniques such as snap rings, locking collars and interference fits
K 5	types of bearings
K 6	types of oil seals
K 7	adhesives and joining techniques
K 8	types of components such as pumps, sprockets and chains, clutches, hydraulics

Sub-task

B-5.01 **Disassembles components.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.01.01	read documentation to assess required disassembly
B-5.01.02	select hand tools such as gear pullers, hex keys and snap-ring pliers
B-5.01.03	remove necessary components
B-5.01.04	mark components and sketch to aid reassembly if necessary

Sub-task

B-5.02 **Analyzes components.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.02.01	clean the components to remove debris and undesired substances
B-5.02.02	visually inspect the condition of components for defects such as breakage, cracks, excessive wear and damaged seals
B-5.02.03	measure the component for compliance with specifications using inspection equipment such as dial indicator, bore gauge and caliper
B-5.02.04	document findings of analysis for records

Sub-task

B-5.03 Assembles components.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

B-5.03.01	read documentation to assess required assembly
B-5.03.02	select hand tools such as feeler gauges, wrenches, hex keys and snap-ring pliers
B-5.03.03	lay out and verify components before assembly
B-5.03.04	fit components to required specifications using techniques such as lapping, honing, scraping and filing
B-5.03.05	measure and check fit throughout the process to make adjustments
B-5.03.06	identify process problems such as misalignment, incorrect fits and incorrect torque pressure
B-5.03.07	verify repaired assembly meets specifications

BLOCK C — DRILL PRESSES

Context — Machinists use drill presses to drill, ream, bore and tap holes. Drill presses are also used for form cutting operations such as countersinking, counterboring, chamfering and spot facing. Drill presses are an integral part of a machine shop. Comprehensive drill press skills are essential for fully qualified machinists.

Trends — Drill presses are being used less frequently; however, the skills related to drill presses are still essential to the trade.

Related Components — Not applicable.

Tools and Equipment — See Appendix A.

Task 6 — Sets up drill presses.

Required Knowledge

K 1	drill press types such as radial arm drill, sensitive drill press and pedestal drill
K 2	capacity of drill press
K 3	size and types of cutting tools such as drills, reamers, boring bars and taps
K 4	drill press operations such as centre drilling, drilling, boring, counterboring, countersinking, spot facing, tapping and reaming
K 5	order of drill press operations
K 6	types of work holding devices such as vises, V-blocks and angle plates
K 7	clamping pressure
K 8	capacity of work holding device
K 9	types of jigs and fixtures
K 10	cutting tool characteristics such as shape, grade, geometry and capacity
K 11	workpiece characteristics such as shape, material and size

K 12	cutting tool capacities such as depth of cut, cutting speed and feed, and chip load
K 13	cutting tool materials such as carbide and high-speed steel (HSS)

Sub-task

C-6.01 Selects drill press types.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.01.01	read documentation to determine operations to be performed
C-6.01.02	determine type of drill press according to operations and workpiece

---

Sub-task

C-6.02 Plans drill press sequence.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.02.01	read documentation to assess operations
C-6.02.02	determine order of operations to be performed
C-6.02.03	select tools according to operations
C-6.02.04	select work holding devices such as vises, soft jaws, parallel clamps and c-clamps

Sub-task

C-6.03 Selects drill press speeds and feeds.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.03.01	determine type of material based on specifications such as drawings and material test report (MTR) of material to be drilled
C-6.03.02	determine surface speed using pre-determined data such as cutting tool manufacturers' specifications, charts and *Machinery's Handbook*
C-6.03.03	determine spindle speed using diameter of cutter and surface speed
C-6.03.04	determine the feed rate for a drill bit
C-6.03.05	adjust machine controls to calculated settings
C-6.03.06	readjust machine controls based on cutting performance

Sub-task

C-6.04 Sets up jigs, fixtures and work holding devices for drill presses.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.04.01	determine orientation of workpiece on the table
C-6.04.02	mount, align and secure work holding device and fixtures
C-6.04.03	clamp jig to workpiece or tooling as required
C-6.04.04	adjust table or column height to maximize rigidity

Sub-task

C-6.05 **Sets up tooling for drill presses.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-6.05.01	inspect for wear and clean tooling to ensure accuracy
C-6.05.02	install required tool in spindle
C-6.05.03	adjust stop to required tool depth

Task 7 Operates drill presses.

Required Knowledge

K 1	tool geometry and material
K 2	drilling techniques such as pecking, trepanning and deep-hole drilling
K 3	reference material to determine fastener size and types
K 4	reference material to determine counterbore diameter and corresponding pilot diameter
K 5	required surface finish
K 6	tap types such as spiral flute, straight flute, spiral point and staggered tooth
K 7	thread types such as UNF, UNC, Acme, NPT, NPS and metric (SI)
K 8	hole finishing techniques such as spot facing, boring and reaming

Sub-task

C-7.01 **Drills holes using a drill press.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.01.01	install centre drill for application
C-7.01.02	centre drill the workpiece
C-7.01.03	install drill for application

C-7.01.04	feed drill into workpiece to produce hole
C-7.01.05	measure and check hole throughout the process to make adjustments
C-7.01.06	identify process problems such as drill wandering, oversized holes and damage to cutting tool
C-7.01.07	verify feature meets specifications using inspection equipment such as telescopic gauge, small hole gauge and calipers

---

Sub-task

C-7.02 **Cuts countersinks, counterbores, chamfers and spot faces using a drill press.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.02.01	pre-drill workpiece to required size allowance for application
C-7.02.02	install required tool for application
C-7.02.03	identify process problems such as chatter, damage to cutting tool, burring and insufficient depth
C-7.02.04	measure and check hole throughout the process to make adjustments
C-7.02.05	complete operation to required dimensions
C-7.02.06	verify feature meets specifications using inspection equipment such as sample piece, depth micrometer and calipers

---

Sub-task

C-7.03 **Performs tapping using a drill press.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.03.01	select taps according to specifications such as material and type of hole
C-7.03.02	pre-drill workpiece using tooling such as centre drill and tap drill
C-7.03.03	set up taps in drill press using tooling such as tapping heads, collets and chucks

C-7.03.04	identify process problems such as damaged threads, broken taps, insufficient cutting fluid and cross threading
C-7.03.05	verify feature meets specifications using inspection equipment such as plug gauge and sample piece

---

Sub-task

C-7.04 Finishes holes using a drill press.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

C-7.04.01	read documentation for specifications
C-7.04.02	set up tooling such as drill, reamer and boring bar according to operation and select lubricant
C-7.04.03	measure and check hole throughout the process and make adjustments
C-7.04.04	identify process problems such as surface finish defects, under/oversized holes and damage to cutting tool
C-7.04.05	verify hole meets specifications using inspection equipment such as bore gauge, telescopic gauge, caliper and inside micrometer

BLOCK D — CONVENTIONAL LATHES

Context	Machinists use conventional lathes including engine lathes, turret lathes and vertical lathes for operations such as turning, boring and threading. Comprehensive lathe skills are essential for fully qualified machinists.
Trends	No trends identified.
Related Components	Not applicable.
Tools and Equipment	See Appendix A.

Task 8 — Sets up conventional lathes.

Required Knowledge

K 1	lathe types such as engine lathes, turret lathes and vertical lathes
K 2	capacity of lathe such as swing and size
K 3	lathe operations such as turning, threading and boring
K 4	machining capacity of lathe
K 5	sequence of lathe operations
K 6	lathe alignment and lathe maintenance according to manufacturers' specifications
K 7	types of work holding devices such as four-jaw chuck, three-jaw chuck, face plate, fixtures, magnetic chuck, collets, centres and drive dogs
K 8	clamping pressure
K 9	capacity of work holding device
K 10	spindle nose types such as cam lock, threaded and long taper
K 11	types of tooling such as indexable insert, HSS and brazed carbide
K 12	cutting tool characteristics such as shape, grade, geometry and capacity and dimensions
K 13	installation and positioning techniques
K 14	types of accessories such as taper attachments, steady rests and follower rests
K 15	contact material for steady rests and follower rests such as bronze pads, brass pads, roller bearings and leather pads

K 16	workpiece characteristics such as shape, material and size
K 17	setup and alignment techniques such as dialing-in and shimming
K 18	cutting tool capacities such as depth of cut, cutting speed and feed, and chip load
K 19	cutting tool materials such as carbide, HSS and ceramic
K 20	size and types of cutting tools such as boring bars, facing tools and turning tools
K 21	application of anti-vibration boring bars to improve cutting efficiency and surface finish

---

Sub-task

D-8.01 Selects conventional lathe types.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.01.01	read documentation to determine operations to be performed
D-8.01.02	determine lathe according to workpiece size and quantity

---

Sub-task

D-8.02 Plans sequence of operations for conventional lathes.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.02.01	read documentation to determine operations to be performed
D-8.02.02	determine order of operations to be performed
D-8.02.03	select work holding devices such as three-jaw chuck, four-jaw chuck, face plate and collet chuck
D-8.02.04	select tools and accessories such as steady rest, taper attachment and lathe dog according to operations

Sub-task

D-8.03 **Sets up work holding devices for conventional lathes.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.03.01	clean and check spindle and work holding device for damage and debris
D-8.03.02	protect bedways
D-8.03.03	mount work holding device using hoisting equipment such as chain block and crane
D-8.03.04	secure work holding device using tools such as wrench, key and hook spanner
D-8.03.05	install and use spindle stops when required

Sub-task

D-8.04 **Sets up tooling for conventional lathes.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.04.01	check for clearance to ensure operation can be completed
D-8.04.02	adjust tool angle in relation to the workpiece and required machining operation
D-8.04.03	adjust tool to machine centre height

Sub-task

D-8.05 **Sets up conventional lathe accessories.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.05.01	read documentation to determine operations to be performed
D-8.05.02	inspect for wear and clean accessories to ensure accuracy
D-8.05.03	adjust, position and secure accessories such as taper attachments, steady rests and follower rests
D-8.05.04	identify problems such as misalignment and run-out

Sub-task

D-8.06 **Sets up workpiece on conventional lathe.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.06.01	mount workpiece in position
D-8.06.02	secure workpiece with work holding devices for drive and stability
D-8.06.03	check and adjust workpiece for run-out and distortion using inspection equipment such as dial indicator, micrometer and surface gauge

Sub-task

D-8.07 **Selects conventional lathe speeds and feeds.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.07.01	determine type of material based on specifications such as drawings and MTR of material to be turned
D-8.07.02	calculate surface speed using pre-determined data such as cutting tool manufacturers' specifications, charts and *Machinery's Handbook*
D-8.07.03	determine spindle speed (rpm) using cutting speed of material and workpiece diameters
D-8.07.04	select feed rate considering factors such as chip load and required surface finish
D-8.07.05	adjust machine controls to calculated settings
D-8.07.06	readjust machine controls based on cutting performance

Sub-task

D-8.08 **Sets up eccentrics on conventional lathes.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-8.08.01	read documentation to determine operations to be performed
D-8.08.02	adjust the position of workpiece to meet required specifications
D-8.08.03	measure and check workpiece location using a dial indicator
D-8.08.04	counterbalance setup as required

Task 9 — Operates conventional lathes.

Required Knowledge

K 1	required surface finish
K 2	tool geometry
K 3	procedures for straight turning
K 4	types of tapers such as Morse, Brown & Sharpe and non-standardized
K 5	procedures for turning tapers such as using taper turning attachments, using compound rests and tail stock offsets
K 6	types of knurls
K 7	procedures such as knurling, parting and grooving
K 8	tools and tool holders
K 9	types of parting and grooving tools such as carbide and HSS
K 10	drilling techniques such as pecking, trepanning and deep-hole drilling
K 11	hole finishing techniques such as drilling, reaming and boring
K 12	types of common threads such as UNC, NPT, Acme and metric (SI)
K 13	procedures and techniques to produce internal and external threads
K 14	single and multi-start threads
K 15	procedures for turning eccentric diameters

Sub-task

D-9.01 Turns external surfaces using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.01.01	read documentation to determine operations to be performed
D-9.01.02	touch off tool on workpiece to establish primary reference point
D-9.01.03	cut workpiece and measure to establish datum
D-9.01.04	rough-turn to remove material and to prepare for finishing operation
D-9.01.05	measure workpiece throughout the process to make adjustments
D-9.01.06	identify process problems such as chatter, tool deflection, taper and run-out

D-9.01.07	finish-turn to comply with specifications
D-9.01.08	verify workpiece meets specifications using inspection equipment such as micrometers, depth micrometers, dial indicators and vernier calipers

---

Sub-task

D-9.02 Bores holes using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.02.01	read documentation to determine operations to be performed
D-9.02.02	touch off tool on workpiece to establish primary reference point
D-9.02.03	rough-bore workpiece and measure to establish datum
D-9.02.04	rough-bore to remove material and to prepare for finishing operation
D-9.02.05	measure workpiece throughout the process to make adjustments
D-9.02.06	identify process problems such as chip and tool clearance, chatter, tool deflection, taper and run-out
D-9.02.07	finish-bore to comply with specifications
D-9.02.08	verify workpiece meets specifications using inspection equipment such as inside micrometers, depth micrometers, dial indicators and bore gauges

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Sub-task

D-9.03 Faces surfaces using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.03.01	read documentation to determine operations to be performed
D-9.03.02	touch off tool on workpiece to establish primary reference point
D-9.03.03	rough-face workpiece and measure to establish datum
D-9.03.04	rough-face to remove material and to prepare for finishing operation
D-9.03.05	measure workpiece throughout the process to make adjustments

D-9.03.06	identify process problems such as chatter, tool wear and incorrect tool height setting
D-9.03.07	finish-face to comply with specifications
D-9.03.08	verify workpiece meets specifications using inspection equipment such as precision square, straight edge, micrometer and dial indicator

---

Sub-task

D-9.04 **Turns tapers on a conventional lathe.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.04.01	read documentation to determine operations to be performed
D-9.04.02	set compound rest, taper attachment or tail stock offset to required angle
D-9.04.03	touch off tool on workpiece to establish primary reference point
D-9.04.04	rough-turn or -bore to remove material and to prepare for finishing operation
D-9.04.05	measure workpiece using inspection equipment such as taper gauges and dial indicators throughout the process to make adjustments
D-9.04.06	identify process problems such as chip and tool clearance, chatter, tool deflection, incorrect taper and run-out
D-9.04.07	finish-turn or -bore to comply with specifications
D-9.04.08	verify workpiece meets specifications using inspection equipment such as taper gauges, dial indicators and micrometers

---

Sub-task

D-9.05 **Knurls using a conventional lathe.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.05.01	read documentation to determine operations to be performed
D-9.05.02	select knurling tool
D-9.05.03	engage tool to workpiece by applying cross-slide pressure
D-9.05.04	feed tool along required length of knurl

D-9.05.05	apply increased pressure on the knurled surface until required profile is formed
D-9.05.06	visually inspect workpiece throughout the process
D-9.05.07	identify process problems such as galling, flaking and incorrect form
D-9.05.08	finish knurl to comply with specifications
D-9.05.09	verify workpiece meets specifications using inspection equipment such as micrometers and sample piece

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Sub-task

D-9.06 Parts off workpiece using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.06.01	read documentation to determine operations to be performed
D-9.06.02	touch off tool on workpiece to establish reference point
D-9.06.03	measure tool location from reference point
D-9.06.04	determine the centre height of tool
D-9.06.05	feed tool into workpiece and catch part
D-9.06.06	clear chips to allow lubricant/coolant to reach tool tip
D-9.06.07	visually inspect workpiece throughout the process
D-9.06.08	identify process problems such as chattering, galling and tool wandering
D-9.06.09	finish workpiece to comply with specifications
D-9.06.10	verify workpiece meets specifications using inspection equipment such as micrometers, straight edges and calipers
D-9.06.11	ensure parted workpiece is retained without damage to workpiece or equipment

Sub-task

D-9.07 Drills using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.07.01	read documentation to determine operations to be performed
D-9.07.02	install drill chuck with centre drill into tail stock
D-9.07.03	centre drill the workpiece
D-9.07.04	install drill for application
D-9.07.05	feed drill into workpiece to produce hole and manage swarth
D-9.07.06	measure and check hole throughout the process to make adjustments
D-9.07.07	identify process problems such as drill wandering, oversized holes, misalignment of tail stock/turret and damage to cutting tool
D-9.07.08	verify feature meets specifications using inspection equipment such as pin gauges, go-no-go gauges and calipers

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Sub-task

D-9.08 Reams holes using a conventional lathe.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.08.01	read documentation to determine operations to be performed
D-9.08.02	install reamer in the tail stock/turret for application
D-9.08.03	feed reamer into workpiece to create a finished hole
D-9.08.04	identify process problems such as chatter, oversized holes, misalignment of tail stock/turret and damage to cutting tool
D-9.08.05	verify feature meets specifications using inspection equipment such as go-no-go gauges, bore gauges and telescopic gauge

Sub-task

D-9.09 **Cuts grooves using a conventional lathe.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.09.01	read documentation to determine operations to be performed
D-9.09.02	touch off tool on workpiece to establish reference points
D-9.09.03	feed tool into workpiece
D-9.09.04	measure and check groove throughout the process to make adjustments
D-9.09.05	control chips to allow cutting fluid to reach tool tip
D-9.09.06	visually inspect workpiece throughout the process
D-9.09.07	identify process problems such as chattering, galling and tool wandering
D-9.09.08	finish workpiece to comply with specifications
D-9.09.09	verify workpiece meets specifications using inspection equipment such as gauge blocks, groove micrometers and caliper

Sub-task

D-9.10 **Cuts threads using a conventional lathe.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

D-9.10.01	read documentation to determine operations to be performed
D-9.10.02	adjust gear box for required thread pitch
D-9.10.03	use center gauge to establish required angle on tool
D-9.10.04	touch off tool on workpiece to establish primary reference
D-9.10.05	machine a test pass to verify thread pitch
D-9.10.06	measure thread pitch using thread gauge, calipers and test pieces
D-9.10.07	machine workpiece to required thread specifications
D-9.10.08	deburr threaded workpiece to remove sharp edges

D-9.10.09	identify process problems such as chatter, tool deflection and taper
D-9.10.10	verify workpiece using inspection equipment such as thread wires, thread micrometers, go-no-go gauges and sample pieces

BLOCK E CONVENTIONAL MILLING MACHINES

Context	A machinist uses conventional milling machines to make precision parts. Conventional milling machines are primarily used for low production and tool room work.
Trends	Not applicable.
Related Components	Not applicable.
Tools and Equipment	See Appendix A.

Task 10 Sets up conventional milling machines.

Required Knowledge

K 1	milling machine types such as vertical, horizontal, ram and turret, and horizontal boring machines
K 2	capacity of milling machine
K 3	milling techniques such as climb milling and conventional milling
K 4	milling techniques for cutting spur, helical, bevel and worm gears, splines and racks
K 5	milling machine operations such as facing, contouring, cutting T-slots and dovetails, and boring
K 6	indexing operations such as direct, simple and differential
K 7	roughing and finishing operations
K 8	sequence of milling operations
K 9	clamping pressure
K 10	capacity of work holding device
K 11	types of work holding devices such as vises, angle plates, V-blocks, jigs and fixtures
K 12	mounting, setup and aligning techniques and procedures
K 13	types of tooling such as HSS and carbide endmills, fly cutters, ceramic, and carbide inserts
K 14	cutting tool characteristics such as shape, grade, geometry and capacity

K 15	types of accessories such as rotary tables, boring heads and indexing heads
K 16	workpiece characteristics such as shape, material and size
K 17	size and types of cutting tools such as boring bars, end mills and face mills
K 18	the effect of speeds, feeds and depth of cut on finish and cutter life

---

Sub-task

E-10.01 Selects conventional milling machine types.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	Yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.01.01	read documentation to determine machining requirements
E-10.01.02	match machine type to project requirements such as operations involved and the size of the workpiece

---

Sub-task

E-10.02 Plans milling sequence.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.02.01	read documentation to identify milling procedures such as conventional milling, climb milling and slot milling
E-10.02.02	determine order of procedures
E-10.02.03	select work holding devices such as three-jaw chuck, vise, indexing head, rotary table and fixtures
E-10.02.04	assess tooling requirements

Sub-task

E-10.03 Sets up work holding devices for conventional milling machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.03.01	inspect and clean work holding device and correct deficiencies
E-10.03.02	perform required alignments using tools such as dial indicators, squares and gauge blocks
E-10.03.03	fasten and adjust work holding device using required clamping pressures

Sub-task

E-10.04 Sets up tooling for conventional milling machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.04.01	match workpiece requirements by selecting tooling such as end mills, shell mills, indexable carbide inserts and boring bars
E-10.04.02	inspect for wear and clean tooling to ensure accuracy
E-10.04.03	align tooling using dial indicators to ensure concentricity
E-10.04.04	install tooling using required clamping pressures

Sub-task

E-10.05 Sets up milling accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.05.01	match workpiece requirements by selecting accessories such as rotary tables, vises, universal dividing heads and boring heads
E-10.05.02	inspect for wear and clean accessories to ensure accuracy
E-10.05.03	align accessories using tools such as dial indicators, gauge blocks and squares
E-10.05.04	install and secure accessories using required clamping pressures

---

Sub-task

E-10.06 Sets up workpiece on a conventional milling machine.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.06.01	prepare workpiece by eliminating burrs and debris
E-10.06.02	install and secure workpiece in holding device or directly on conventional milling machine table
E-10.06.03	check alignment of workpiece using tools such as dial indicator, precision square and gauge blocks to ensure accuracy
E-10.06.04	establish work datum by using tools such as edge finders, dial indicator or milling cutter

Sub-task

E-10.07 Selects conventional milling machine speeds and feeds.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-10.07.01	determine type of material based on specifications such as drawings and MTR of material to be milled
E-10.07.02	calculate surface speed using pre-determined data such as cutting tool manufacturers' specifications, charts and *Machinery's Handbook*
E-10.07.03	determine spindle speed (rpm) using diameter of cutter and surface speed
E-10.07.04	calculate feed rate using rpm, number of cutter teeth and recommended chip load per tooth
E-10.07.05	adjust machine controls to calculated settings
E-10.07.06	readjust machine controls based on cutting performance

Task 11 Operates conventional milling machines.

Required Knowledge

K 1	required surface finish
K 2	methods of milling such as climb milling and conventional milling
K 3	types of form cutting operations and associated tools
K 4	form cutting tool capability, speeds and feeds
K 5	types and applications of specialized cutters
K 6	coolant and cutting fluid requirements for conventional milling operations
K 7	procedures for cutting pockets and profiles such as T-slots, dovetails and keyways
K 8	drilling techniques such as pecking, trepanning and deep-hole drilling
K 9	tool geometry and composition
K 10	fastener sizes and types for selected operation
K 11	counterbore diameter and corresponding pilot diameter
K 12	types of threads such as UNF, UNC and metric (SI)
K 13	hole finishing techniques such as drilling, reaming and boring
K 14	types of gears such as bevel, spur, helical, worm and rack

K 15	gear cutting nomenclature
K 16	types of taps and tap drill sizes
K 17	digital readout

Sub-task

E-11.01 **Mills surfaces using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.01.01	touch off milling cutter to workpiece surface to establish a reference point
E-11.01.02	measure workpiece to determine amount of excess material using inspection equipment such as depth micrometers, gauge blocks and dial indicators
E-11.01.03	remove excess material to meet specifications
E-11.01.04	identify surface finish defects caused by process problems such as incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear and insufficient coolant
E-11.01.05	verify workpiece meets specifications using inspection equipment such as gauge blocks, micrometers, calipers, straight edge, square and dial indicator

---

Sub-task

E-11.02 **Mills profiles and pockets using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.02.01	touch off milling cutter to workpiece surface to establish a reference point
E-11.02.02	touch off cutter on datum surface
E-11.02.03	rough out workpiece using tooling such as an indexable carbide end mill, roughing end mill and corner rounding tool
E-11.02.04	measure roughed-out workpiece to make finish adjustments
E-11.02.05	finish workpiece using tooling such as a carbide end mill, finishing end mill and corner rounding tool

E-11.02.06	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant and chip evacuation
E-11.02.07	verify workpiece meets specifications using inspection equipment such as gauge blocks, radius gauges, micrometers, calipers and dial indicator

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Sub-task

E-11.03 **Mills slots, grooves and keyways using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.03.01	use edge finder or cutter to locate datum surface
E-11.03.02	touch off milling cutter to workpiece surface to establish a reference point
E-11.03.03	rough out workpiece using tooling such as an indexable end mill, roughing end mill and side face cutter
E-11.03.04	measure roughed-out workpiece to make finish adjustments
E-11.03.05	finish workpiece using tooling such as a carbide end mill, finishing end mill, dovetail cutter, woodruff cutter and T-slot cutter
E-11.03.06	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant and chip evacuation
E-11.03.07	verify workpiece meets specifications using inspection equipment such as gauge blocks, depth micrometers, calipers and dial indicators

Sub-task

E-11.04 **Cuts gears and splines using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.04.01	perform calculations to determine gear or spline dimensions and select form cutter
E-11.04.02	calculate indexing requirements for the number of teeth to be cut
E-11.04.03	use edge finder to locate datum surface
E-11.04.04	touch off milling cutter to workpiece surface to establish a reference point
E-11.04.05	rough out workpiece using form cutter
E-11.04.06	measure roughed-out workpiece to make finish adjustments using tools such as gear-tooth vernier, caliper, wires and micrometers
E-11.04.07	finish workpiece using tooling such as a gear-tooth cutter or an end mill
E-11.04.08	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, improper cutter geometry, tool wear, insufficient coolant and chip evacuation
E-11.04.09	verify workpiece meets specifications using inspection equipment such as gear-tooth vernier, caliper, wires and micrometers

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Sub-task

E-11.05 **Drills holes using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.05.01	assess hole requirements to determine tooling such as centre drills, spot drills and drills
E-11.05.02	touch off drill to workpiece surface to establish a reference point
E-11.05.03	pre-drill workpiece using tooling such as centre drill and pilot drill
E-11.05.04	identify process problems such as incorrect speeds and feeds, wrong depth of cut, incorrect cutter geometry, tool wear, insufficient coolant and chip evacuation

E-11.05.05	complete operation using finish drill
E-11.05.06	verify workpiece meets specifications using inspection equipment such as telescopic gauge, calipers and hole gauges

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Sub-task

E-11.06 **Reams holes using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.06.01	assess hole requirements to determine tooling such as centre drills, drills and reamers
E-11.06.02	touch off drill to workpiece surface to establish a reference point
E-11.06.03	pre-drill workpiece to required size allowance for reaming, using tooling such as centre drill and pilot drill
E-11.06.04	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient cutting fluid and chip evacuation
E-11.06.05	complete operation using reamer
E-11.06.06	verify workpiece meets specifications using inspection equipment such as telescopic gauge, calipers and hole gauges

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Sub-task

E-11.07 **Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.07.01	assess hole requirements to determine tooling such as countersinks, counterbores, chamfering tool and spot faces
E-11.07.02	touch off tool to workpiece surface to establish a reference point
E-11.07.03	pre-drill workpiece to required size allowance for application

E-11.07.04	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient cutting fluid and chip evacuation
E-11.07.05	complete operation to required dimension
E-11.07.06	verify workpiece meets specifications using inspection equipment such as depth micrometer, calipers and hole gauges

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Sub-task

E-11.08 Performs tapping using a conventional milling machine.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	no	NV	NV	NV

Key Competencies

E-11.08.01	assess hole requirements to determine tooling such as centre drills, tap drills and taps
E-11.08.02	pre-drill workpiece using tooling such as centre drill and tap drill
E-11.08.03	set up taps in milling machine using tooling such as tapping heads, collets and chucks
E-11.08.04	complete operation to required specifications
E-11.08.05	identify process problems such as incorrect speeds and feed pressure, incorrect tap geometry, incorrect tap drill size, cross-threading, tool wear, incorrect or insufficient cutting fluid and chip evacuation
E-11.08.06	verify workpiece meets specifications using inspection equipment such as thread gauge, calipers and go-no-go gauges

Sub-task

E-11.09 Bores holes using a conventional milling machine.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

E-11.09.01	assess hole requirements to determine tooling such as centre drills, drills and boring heads
E-11.09.02	pre-drill workpiece using tooling such as centre drill and rough-drill if required
E-11.09.03	touch off boring tool to workpiece surface to establish a reference point
E-11.09.04	machine workpiece using accessories such as boring head
E-11.09.05	identify process problems such as incorrect speeds and feeds, incorrect depth of cut, incorrect cutter geometry, tool wear, insufficient coolant and chip evacuation
E-11.09.06	verify workpiece meets specifications using inspection equipment such as telescopic gauge, inside micrometers, bore gauges, calipers and surface finish comparators

BLOCK F — POWER SAWS

Context — Horizontal power saws are used to cut material for other machining processes. Vertical band saws are used for sawing contours close to a finish size. Typically, workpieces are then finished using other machining operations.

Trends — There are advances in saw blade materials, which have improved efficiency and durability. Welded blades are inexpensive and consequently, machinists rarely weld their own band saw blades. Water jet, plasma and laser cutting equipment are being used more frequently.

Related Components — Not applicable.

Tools and Equipment — See Appendix A.

Task 12 — Sets up power saws.

Required Knowledge

K 1	types and capabilities of power saws such as vertical, horizontal and reciprocating
K 2	capacity of saw such as speed, feed and size
K 3	work holding and supporting devices such as infeed support and outfeed support
K 4	blade sizes, set, tooth pitch and composition
K 5	types of blade guides such as carbide, roller and bearing
K 6	blade effect on cutting rate, tool life, finish and accuracy
K 7	break-in period of new blades
K 8	blade installation techniques and procedures for various saw types
K 9	workpiece characteristics such as shape, material and size
K 10	clamping pressures
K 11	saw features such as manual stops and automatic indexing devices
K 12	types of power saw accessories such as nesting fixtures, fences, gravity feed and vises

K 13	band saw blade welding procedures such as butt welding and silver solder
K 14	coolant selection
K 15	lock-out procedures

Sub-task

F-12.01 Selects power saw types.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.01.01	read documentation to determine machining requirements such as finish and allowances
F-12.01.02	take measurements of workpiece to be cut to determine which saw to use
F-12.01.03	match power saw type to project requirements

Sub-task

F-12.02 Selects saw blades.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.02.01	read documentation to determine blade requirements
F-12.02.02	check blade pitch and set to match with job requirements such as material cross-sectional thickness and type
F-12.02.03	match vertical band saw blade width to contour to be cut

Sub-task

F-12.03 Installs saw blades.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.03.01	place blade on drive wheel and idler wheel(s)
F-12.03.02	match saw guides to blades on vertical band saw to prevent damage to blades and guides and to ensure required cut
F-12.03.03	adjust blade tension
F-12.03.04	check blade tracking to avoid damage to the blade and saw
F-12.03.05	secure blade of power hacksaw using locating pins
F-12.03.06	verify cutting direction of blade after installation
F-12.03.07	complete cut from opposite side when blade becomes damaged
F-12.03.08	weld vertical band saw blades to saw internal contours
F-12.03.09	break in saw blades to increase blade life

Sub-task

F-12.04 Selects power saw speeds and feeds.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.04.01	match speeds and feeds to material to be cut by referring to blade manufacturers' recommendations
F-12.04.02	adjust speeds and feeds for specific job requirements such as thin wall sections, I-beams and tubing

Sub-task

F-12.05 **Makes power saw adjustments.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.05.01	adjust guide arms for workpiece material width
F-12.05.02	adjust blade guides to ensure adequate blade support
F-12.05.03	adjust vise pressure for job requirements to ensure workpiece is secure and not damaged
F-12.05.04	adjust table angles when using vertical band saw
F-12.05.05	adjust vertical band saw's fence
F-12.05.06	adjust length stop according to required workpiece length
F-12.05.07	verify that there is no workpiece distortion from the clamping pressure

Sub-task

F-12.06 **Sets up workpiece on power saw.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-12.06.01	position and secure workpiece on saw table
F-12.06.02	verify length or contour to be cut
F-12.06.03	use power saw accessories for securing and guiding workpiece
F-12.06.04	adjust table angle to saw tapered edge as required by specifications

Task 13 Operates power saws.

Required Knowledge

K 1	types of saws such as horizontal, vertical and reciprocating
K 2	sawing procedures

Sub-task

F-13.01 Saws straight and angle cuts.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-13.01.01	guide workpiece into vertical band saw blade using a pusher guide (push stick) with consistent cutting pressure to protect blade and provide an efficient cut
F-13.01.02	adjust angle of vise on horizontal saw according to required angle of cut
F-13.01.03	monitor straightness of cut during cutting process
F-13.01.04	square off end of material (reference cut) to ensure an accurate measurement
F-13.01.05	identify process problems such as incorrect speeds and feeds, and binding or overheating blade
F-13.01.06	verify workpiece meets specifications using inspection equipment such as protractors, tape measures and square

Sub-task

F-13.02 Cuts irregular shapes.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

F-13.02.01	guide workpiece into vertical band saw blade using a pusher guide (push stick) with consistent cutting pressure to protect blade and provide an efficient cut
F-13.02.02	monitor angle of cut during cutting process
F-13.02.03	identify process problems such as incorrect speeds and feeds, and binding or overheating blade
F-13.02.04	verify workpiece meets specifications using inspection equipment such as templates and radius gauges

BLOCK G — PRECISION GRINDING MACHINES

Context	Machinists use precision grinding machines to achieve tight tolerance and high quality surface finish.
Trends	Advances in abrasive materials in grinding wheels have increased productivity. Due to common use of indexable carbide tooling, tool and cutter grinding is not as widely practiced.
Related Components	Not applicable.
Tools and Equipment	See Appendix A.

Task 14 — Sets up precision grinding machines.

Required Knowledge

K 1	types of grinding machines such as surface, cylindrical, tool and cutter, and centreless
K 2	capacity of grinding machine
K 3	grinding machine accessories such as support rests and power heads
K 4	types, sizes and grades of grinding wheels such as cubic boron nitride (CBN), aluminum oxide and silicon carbide
K 5	grinding machine operations such as surface, cylindrical, tool and cutter, and centreless grinding
K 6	sequence of grinding machine operations
K 7	types of work holding devices such as centres, four-jaw chuck, three-jaw chuck, face plate, fixtures, magnetic chuck and magnetic sub-plates
K 8	clamping pressure
K 9	capacity of work holding device
K 10	techniques and procedures for storing, handling and mounting grinding wheels
K 11	blotter applications
K 12	balancing techniques and procedures

K 13	truing and dressing techniques and procedures such as contour dressing and diamond dressing
K 14	types of accessories such as rests, internal grinding head, wheel dressers, laminated blocks, magnetic spring clamps, chucks, drive dogs and mandrels
K 15	contact material for steady rests and follower rests such as bronze pads, polymer pads and brass pads
K 16	workpiece characteristics such as shape, material and size
K 17	setup and alignment techniques such as shimming, dialing-in and using sine bars
K 18	the effect of speeds, feeds and depth of cut on finish and wheel life
K 19	types of honing materials

Sub-task

G-14.01 Selects precision grinding machine types.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.01.01	read documentation to determine machining requirements
G-14.01.02	match project requirements to machine such as cylindrical, tool and cutter, and surface

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Sub-task

G-14.02 Plans grinding sequence.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.02.01	read documentation to identify grinding procedures such as surface grinding, cylindrical grinding, and tool and cutter grinding
G-14.02.02	establish order of procedures
G-14.02.03	determine work holding devices such as three-jaw chuck, four-jaw chuck, face plate, fixtures and magnetic chucks
G-14.02.04	determine type and dimensions of material to be ground

G-14.02.05	determine types, size and grades of grinding wheel using charts and documentation
G-14.02.06	choose required honing stones compatible to workpiece material
G-14.02.07	determine workpiece setup procedures for surface grinder
G-14.02.08	determine workpiece setup procedures for cylindrical grinder
G-14.02.09	determine workpiece setup procedures for tool and cutter grinder

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Sub-task

G-14.03 Sets up work holding devices for precision grinding machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.03.01	position work holding devices to accommodate workpiece
G-14.03.02	perform alignments as required
G-14.03.03	secure work holding device

Sub-task

G-14.04 Mounts grinding wheel.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.04.01	visually inspect and ring test grinding wheel for defects such as cracks, stains and gouges
G-14.04.02	secure wheel on required adapters using blotters and flanges
G-14.04.03	balance grinding wheel using wheel balancing equipment such as mandrels and weights
G-14.04.04	install balanced wheel assembly on machine
G-14.04.05	true and dress mounted grinding wheel using diamond dressing tools
G-14.04.06	assess further balancing requirements of installed grinding wheel

Sub-task

G-14.05 Sets up grinding accessories.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.05.01	read documentation to determine required accessories such as angle plate, collets, steady rest, chucks, drive dogs and mandrels
G-14.05.02	select accessory to match workpiece requirement
G-14.05.03	inspect accessories for damage and defects
G-14.05.04	clean and check accessory and mounting surface to ensure accuracy
G-14.05.05	prepare accessories by positioning, fastening and adjusting to accommodate workpiece

Sub-task

G-14.06 Sets up workpiece on precision grinding machines.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.06.01	prepare workpiece by eliminating burrs and debris
G-14.06.02	install workpiece on surface grinder using accessories such as magnetic chuck, vise and fixture to secure workpiece
G-14.06.03	install workpiece on cylindrical grinder using accessories such as magnetic chuck, three-jaw chuck, four-jaw chuck and centres with drive dogs to secure workpiece
G-14.06.04	install workpiece on tool and cutter grinder using accessories such as centres, universal vise and collets to secure workpiece
G-14.06.05	check alignment of workpiece before grinding using tools such as dial indicator, taper gauge and gauge blocks to ensure accuracy
G-14.06.06	shim workpiece to eliminate stressing of the material

Sub-task

G-14.07 Selects precision grinding machine speeds and feeds.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-14.07.01	determine type of material based on specifications such as drawings and MTR of material to be ground
G-14.07.02	determine dimensions of material to be ground to calculate required surface speed
G-14.07.03	adjust feed control such as hydraulic and servo-drive controls to required rate
G-14.07.04	readjust machine controls based on cutting performance

Task 15 Operates precision grinding machines.

Required Knowledge

K 1	types of surface grinders such as vertical and horizontal
K 2	surface grinding techniques required to produce surfaces such as parallel, flat and square
K 3	types of profiles such as Vees and radii
K 4	cylindrical and surface grinding techniques to produce profiles such as angles, radii, recesses, shoulders and special forms
K 5	types of cylindrical grinders such as centreless, universal, external and internal
K 6	setup and alignment techniques for drive plates, grinder carriers, drive dogs, trip dogs, foot stock, centres, chucks, work heads and wheel heads
K 7	types of tool and cutter grinders such as drill grinders and end mill grinders
K 8	accessories for precision grinding machines
K 9	cutter types such as form relief cutters, reamers and end mills
K 10	relief angles and clearances
K 11	honing machines
K 12	honing techniques

Sub-task

G-15.01 Grinds flat surfaces using a surface grinder.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	no	NV	NV	NV

Key Competencies

G-15.01.01	touch off grinding wheel on workpiece surface to establish a reference point
G-15.01.02	measure workpiece to determine amount of excess material using inspection equipment such as depth micrometers, gauge blocks and dial indicators
G-15.01.03	remove required amounts of excess material to meet specifications
G-15.01.04	identify surface finish defects caused by process problems such as incorrect speeds and feeds, depth of cut, wheel loading and incorrect consistency of coolant
G-15.01.05	verify flat surface meets specifications using inspection equipment such as profilometers, surface finish comparators and dial indicators

Sub-task

G-15.02 Grinds profiles.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-15.02.01	dress grinding wheel to desired profile using tools such as radius dressing attachment, dressing stick (stone) and diamond dressing tool
G-15.02.02	touch off grinding wheel on workpiece surface to establish a reference point
G-15.02.03	measure workpiece to determine amount of excess material using inspection equipment such as depth micrometers, contour gauge and dial indicators
G-15.02.04	rough out workpiece profile to remove excess material leaving a finish grinding allowance
G-15.02.05	re-dress wheel then finish grind
G-15.02.06	verify profile meets specifications using inspection equipment such as contour gauges, micrometers, surface finish comparators and dial indicators

Sub-task

G-15.03 Grinds internal and external cylindrical and tapered surfaces.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-15.03.01	dress grinding wheel using tools such as dressing stick (stone) and diamond dressing tool
G-15.03.02	adjust table and dial indicator for required orientation such as taper and parallelism
G-15.03.03	touch off grinding wheel on workpiece surface to establish a reference point
G-15.03.04	measure workpiece to determine amount of excess material using inspection equipment such as micrometers, sine bars and dial indicators
G-15.03.05	rough out workpiece to remove excess material leaving a finish grinding allowance
G-15.03.06	re-dress wheel then finish grind
G-15.03.07	re-measure workpiece to confirm specifications are met using inspection equipment such as bore gauges, micrometers, surface finish comparators and dial indicators

Sub-task

G-15.04 Grinds tools and cutters.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	no	NV	NV	NV

Key Competencies

G-15.04.01	dress grinding wheel using tools such as dressing stick (stone) and diamond dressing tool
G-15.04.02	mount cutting tools such as end mills, reamers and form relief cutters
G-15.04.03	set cutting tool rest to establish required relief angle and clearance
G-15.04.04	touch off grinding wheel on workpiece surface to establish a reference point
G-15.04.05	grind cutting edge of tools to establish required tool geometry

Sub-task

G-15.05 Finishes holes using a honing machine.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
no	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

G-15.05.01	establish type of material to be honed such as steel, cast iron and bronze
G-15.05.02	monitor stone pressure to eliminate distortion and optimize material removal
G-15.05.03	match stroke to rpm to achieve required finish
G-15.05.04	identify process problems such as bell mouthing, lack of cylindricity and chatter
G-15.05.05	ensure dimension and tolerance of holes conform to drawings and specifications using bore gauges, sample piece and inside micrometers

BLOCK H — COMPUTER NUMERICAL CONTROL (CNC) MACHINE-TOOLS

Context

Fully qualified machinists use CNC machine-tools for machining that would be difficult or time-consuming on conventional machining equipment. Programming, setting up and operating this equipment requires knowledge of conventional machining methods as well as CNC programming skills and an understanding of machine controls.

Trends

CNC machine-tools are becoming common in smaller shops. They are being used in complex low production runs and one-offs.

Conversational programming is becoming more common allowing for complex programming at the machine-tool. High-speed machining is being used in CNC machine-tools.

Computer-aided manufacturing (CAM) systems may be used to provide off-line programming for CNC equipment.

Related Components

Not applicable.

Tools and Equipment

See Appendix A.

Task 16 — Performs basic CNC programming.

Required Knowledge

K 1	order of CNC machining operations
K 2	Cartesian Coordinate System
K 3	related mathematical skills such as trigonometry, algebra and geometry
K 4	types of CNC machine controls
K 5	programming methods such as G code, M code and conversational
K 6	computer-aided design (CAD) and CAM

Sub-task

H-16.01 Reviews process documentation.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-16.01.01	interpret workpiece documentation such as setup sheets and engineering drawings
H-16.01.02	locate information required for CNC machining such as part origin and orientation, and location of work holding devices

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Sub-task

H-16.02 Calculates coordinates for tool path.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-16.02.01	determine types of cutting tools to be used in machining operation
H-16.02.02	generate program points using trigonometry and Cartesian Coordinate System
H-16.02.03	use software and built-in features of the machine control to generate cutter paths
H-16.02.04	compensate for tool nose radius and cutter radius compensation in calculations
H-16.02.05	plan entry and exit moves to engage or cancel cutter compensation

Sub-task

H-16.03 **Creates basic program.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-16.03.01	establish safety blocks of code in order to cancel previous code and initialize machine at a start point
H-16.03.02	use G code, M code and conversational method to produce program
H-16.03.03	interpret and review codes from program

Sub-task

H-16.04 **Inputs program into control memory.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-16.04.01	use input functions such as "insert", "alter" and "delete"
H-16.04.02	download program from PC, network or storage devices

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Sub-task

H-16.05 **Optimizes program.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-16.05.01	adjust speed and feed overrides to ensure peak program efficiency and surface finish quality
H-16.05.02	record changes to speed and feed overrides
H-16.05.03	modify cutting paths to ensure most efficient removal of material
H-16.05.04	save optimized program on storage media for future reference

Task 17 Sets up CNC machine-tools.

Required Knowledge

K 1	types of tooling such as indexable insert tooling, HSS tooling, solid carbide end mills and specialty coated tooling
K 2	types of tool holders
K 3	cutting tool characteristics such as shape, grade, geometry and capacity
K 4	tool holder characteristics
K 5	cutting tool and tool holder identification systems
K 6	types and features of automatic tool changers such as carousel, magazine and turret
K 7	types of CNC machine controls
K 8	machine codes and techniques to establish work datum
K 9	workpiece characteristics such as shape, material and size
K 10	setup and alignment techniques such as dialing-in and shimming
K 11	programming methods such as G code, M code and conversational

Sub-task

H-17.01 Selects tooling and tool holders for CNC machine-tools.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-17.01.01	read setup sheet or tooling list for information such as tooling offsets and available tooling and tool holders
H-17.01.02	determine if tool and holder shape will allow for enough clearance
H-17.01.03	assess tooling properties such as rigidity and maximum capacity to optimize material removal
H-17.01.04	match tool holder taper and pull-stud to machining centre
H-17.01.05	match tool shank sizes to turning centres in order to ensure accurate centre height

Sub-task

H-17.02 **Sets up tooling and tool holders for CNC machine-tools.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-17.02.01	check that mounting surfaces are clean and free of damage
H-17.02.02	use tool holding device such as clamping screw, collets and shrink fit
H-17.02.03	locate and secure tooling in tool holder to ensure access to all part features and adequate clearances
H-17.02.04	space tooling for efficient tool changes
H-17.02.05	space tooling to eliminate interference with chucks or workpieces in CNC turning centres
H-17.02.06	match tool to programmed tool location
H-17.02.07	install tool and tool holder in orientation required by specific machine-tool and cutting process
H-17.02.08	determine tool offsets using methods such as using automatic tool presetters and touching off tool on workpiece surface

Sub-task

H-17.03 **Sets up workpiece on CNC machine-tool.**

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-17.03.01	select work holding device such as vise, fixtures, clamps and soft jaws
H-17.03.02	clean workpiece and remove chips or debris to maintain part locating accuracy on work holding devices
H-17.03.03	machine soft jaws to match workpiece requirements
H-17.03.04	adjust clamping pressure according to workpiece requirements
H-17.03.05	evaluate the potential for damage from work holding pressure and take precautions necessary to protect workpiece
H-17.03.06	verify part is in contact with locating surfaces with methods such as using feeler gauges and performing visual inspection

H-17.03.07 install workpiece in correct orientation according to setup sheet or machining requirements

H-17.03.08 set up accessories such as tail stock, steady rest and fourth axis

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Sub-task

H-17.04 Establishes work datum.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-17.04.01 verify location of work datum by referring to setup sheets

H-17.04.02 touch off on designated datum surfaces of workpieces using tools such as probes and edge finders

H-17.04.03 face off surface to locate designated datum

H-17.04.04 input datum information into specific machine offset register as determined by setup sheet or tooling list

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Sub-task

H-17.05 Verifies program.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-17.05.01 confirm program reference number

H-17.05.02 anticipate interference with work holding devices

H-17.05.03 perform dry run or graphic simulation of program in order to verify datum, tool path and tool sequence

H-17.05.04 use features such as single block mode, distance to go, feed hold and feed override to step through program

H-17.05.05 confirm and retain program modifications and update master file

Task 18 Operates CNC machine-tools.

Required Knowledge

K 1	types of CNC machine controls
K 2	types of offsets and compensations such as length, diameter and tool nose radius
K 3	work holding devices
K 4	clamping pressure
K 5	tool life expectancy
K 6	load monitoring system
K 7	machine alarms and alarm codes
K 8	manual cycle stop/start procedures according to types of machines

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Sub-task

H-18.01 Adjusts offsets.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-18.01.01	measure workpiece dimensions
H-18.01.02	implement roughing and finishing operations to achieve required tolerances
H-18.01.03	calculate deviations according to measurements
H-18.01.04	enter offset changes into offset register

Sub-task

H-18.02 Monitors machining processes.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-18.02.01	verify appropriate clamping pressure by checking if workpiece is moving in the work holding device
H-18.02.02	verify adequate coolant flow to facilitate chip removal, and maintain required surface finish and tool life
H-18.02.03	observe operating conditions such as sound, vibrations and abnormal chip formations
H-18.02.04	assess tool wear by using procedures such as reading spindle and drive axis load meters, and checking surface finish and workpiece sizes

Sub-task

H-18.03 Interrupts program cycle.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-18.03.01	determine level of urgency requiring a stop
H-18.03.02	recognize points in program where interruptions are not safe
H-18.03.03	use control features such as single block mode, feed override and feed hold
H-18.03.04	use emergency stop feature to prevent equipment damage and personal injuries

Sub-task

H-18.04 Restarts program cycle.

NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU
yes	yes	yes	no	yes	yes	yes	yes	yes	yes	NV	NV	NV

Key Competencies

H-18.04.01	position machine to avoid collision
H-18.04.02	identify and execute required elements of program code in order to safely restart program
H-18.04.03	clear machine control's temporary memory (buffer) to prevent unexpected machine movements upon restart
H-18.04.04	restart at correct tool and program location
H-18.04.05	monitor distance to go to prevent collisions

APPENDICES

APPENDIX A — TOOLS AND EQUIPMENT

Safety Equipment

automated external defibrillator (AED)
dust mask
eye wash station
face shield
fall arrest
fire blanket
fire extinguishers
fire hoses
first aid station
goggles/safety glasses
hand protection
hearing protectors
heat treatment oven mitts/gloves
portable gas detector
protective head gear
respirators
safety barrier tapes
safety boots

Hand Tools

acetylene torch
arbour press
bearing extractor
brushes
buffing wheels
chisels (flat cold, diamond, round nose, cape, side)
chuck key
deburrers
die stock
dressing stick
drill drift
drill gauge
file cards
file handles
files (flat file, half round file, hand file, knife file, general purpose file, pillar file, round file, square file, three square file)
grease guns
hacksaws and blades
hammers/mallets (ball peen, dead blow, sledge, cross peen, straight peen)
hand broaches
hand reamers (solid, expansion, adjustable, taper, roughing, finishing taper)
hex keys
honing stones
lapping plate
metal stamps
oil cans/guns
pliers (standard, tongue and groove, needle nose, locking)
punches and bars (pin punch, prick punch, centre punch, aligning punch, pry bar, transfer punch, brass drifts)
scrapers (cylindrical, flatbed)
screwdrivers (straight or flat, Phillips, Robertson, Torx)
soft jaws
spotting blue
tap extractors
tap wrenches
tin snips
torch tip lighters
utility knife
vises (bench, machinist's)
wheel dressers (hand held)
wrenches (open-end, box end, sockets, adjustable, hex socket, torque, pipe, chain, strap, spanner)

Power Tools

air grinder
air-powered abrasive belt machine
angle grinder
bench grinder
buffing tools
cold cut saw
die grinder
disk grinder
line boring equipment
magnetic drill press
nibbler
portable band saw
portable drill
portable key seat cutter
vibrating drum sander

Machine-Tools

abrasive cut-off saw
boring machines (horizontal and vertical)
computer numerical control (CNC) machine-tools (drilling machines, turning centres, machining centres (horizontal and vertical), grinding machines, electrical discharge machines (EDM)(wire and die sinker, water jet cutter)
conventional drilling machines (sensitive drill press, multi-spindle head, radial arm drilling machine, turret drilling machine, pedestal drill)
conventional grinders (cylindrical, surface, tool and cutter, centreless, pedestal)
conventional lathes (turret, engine/centre, single and multi spindle)
conventional milling machines (vertical, horizontal, universal)
conventional sawing machines (band saw (horizontal and vertical), power hacksaw, reciprocating saw)
high temperature oven
hydraulic press

Cutting Tools

abrasive cut off wheels
boring bars
broaches
carbides (cemented, inserts, solid, coated)
counterbores (with or without changeable pilots)
dies
drills
grinding wheels (aluminum oxide, silicon, carbide, boron carbide, cubic boron nitride, diamond)
knurling tools (straight, diamond)
lathe (left and right hand, neutral, parting and grooving)
milling cutters (HSS, carbide, indexable carbide inserts, dovetail, woodruff, side and face, slab, chamfer, fly, gear, endmill, concave, convex)
reamers (machine, hand, spiral flute, straight flute, expandable, rose, taper)
taps

Layout Equipment

combination set
dividers and trammels
etchers
hermaphrodite calipers
layout fluid
layout table
punches (centre, prick, transfer)
scribers
squares (adjustable, solid, master)
surface gauge
surface plates
transfer screws
vernier height gauge

Measuring Tools

angle gauge blocks
angle plate
gun bore gauge
combination square
coordinate measuring machine (CMM)
depth gauge
dial indicators
digital readout
dividers
drill gauge
electronic measuring devices
feeler gauge
gauge blocks/precision blocks/gauge pins
gear measuring wire
go-no-go gauge (threads, diametrical)
hardness tester
height gauge
inside calipers
inspection gauges (fixed gauges, cylindrical plug gauges, plain ring gauges, taper plug gauges, taper ring gauges, thread ring gauges, snap gauges, drill size gauges, radius gauges)
laser
measuring rods
measuring tape
mechanical comparator
micrometer (thread, inside, outside, depth)
optical comparator
outside calipers
plug/ring gauge
precision level
profilometer
protractor (universal, bevel, vernier)
radius gauge
refractometer
scale (steel, rule, hook rule)
sine bar (compound)
sine plate (compound)
small hole gauge
square (solid, adjustable, cylindrical)
steel rules
surface finish comparator
surface plate
telescopic gauge
three wire thread measuring pins
transfer caliper
transfer type instruments
vernier caliper (dial, digital)
vernier height gauge

Setup Accessories and Work Holding Devices

adaptors
angle plates
arbours
boring bars
boring heads
centre and edge finders
centres (dead, half, rotating, spring)
chain hoists
chucks (3-jaw, 4-jaw, magnetic)
clamps
collets
cutting tools
degreasing tank
dividing head
drill chuck
face plates
fixtures/jigs
follower/travelling rest
grinding attachment
grinding wheel balancers
indexing heads
lathe dogs
machine vise
mandrels
overhead crane
parallels quick change tool post
rotary table
screw jacks
shim stock
slings
spacers
spyders
steady rest
taper sleeves
taper turning attachment
tapping head
tool bits
tool holders
turret tool post
v-blocks
vise

APPENDIX B GLOSSARY

blotter	a paper disk placed between grinding wheel and retaining flange, often marked with wheel type and speed rating
boring	a machining process that produces a round straight hole using a single point tool
chamfer	usually a 45 degree angle machined on the start of a bore or a shaft to allow for ease of assembly
computer numerical control (CNC)	the control of a machine-tool using coded instructions from a programmer or an operator
conventional (machine-tools)	traditional, manually controlled machine-tool
counterbore	enlarging the end of a previously created hole, usually to accept a Socket Head Cap Screw (SHCS)
countersink	creating a tapered hole on the end of an existing hole to accommodate a tapered head screw
drill press	a machine used to produce holes in workpieces; reaming, tapping, spot facing and countersinking can also be performed on drill presses
grinder	a machine that removes material from workpieces using abrasive wheels
heat treatment	the heating and cooling of metals to modify their mechanical properties
knurling	using a tool to produce a pattern on the diameter of a workpiece in a lathe
lathe	a machine that holds and rotates the workpiece; a cutting tool is moved on slideways to cut cylindrical, tapered or threaded features on a workpiece
Machinery's Handbook	a reference book used by the mechanical engineering disciplines such as engineers, toolmakers and machinists
mill	a machine that holds the workpiece while a rotating cutter with single or multiple cutting edges cut surfaces and contours
saw	a machine commonly used to cut off workpieces from bar stock using a multi-tooth blade
spot facing	a machining operation that creates a flat surface at 90° to a hole
tapping	cutting threads within a hole using a cutting tool called a tap

traverse grinding	grinding using an automatic feed
trepanning	cutting a groove in the form of a circle or boring or cutting a hole by removing the center or core in one piece

APPENDIX C — ACRONYMS

AED	automated external defibrillator
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineering
CAD	computer-aided design
CAM	computer- aided manufacturing
CBN	cubic boron nitride
CMM	coordinate measuring machine
CNC	computer numerical control
EDM	electrical discharge machines
HSS	high speed steel
MTR	material test report
NPS	National Pipe Straight
NPT	National Pipe Taper
PLC	programmable logic controller
PPE	personal protective equipment
rpm	revolutions per minute
UNC	Unified National Course (a thread system for course threads)
UNF	Unified National Fine (a thread system for fine threads)
WHMIS	Workplace Hazardous Materials Information System

APPENDIX D — BLOCK AND TASK WEIGHTING

BLOCK A COMMON OCCUPATIONAL SKILLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	12	8	10	9	15	9	15	7	5	5	NV	NV	NV	9%

Task 1 Organizes work.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	35	40	36	60	35	20	25	30	33	NV	NV	NV	34%

Task 2 Processes workpiece material.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	30	30	34	15	40	60	55	35	33	NV	NV	NV	38%

Task 3 Maintains machines and tooling.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	35	30	30	25	25	20	20	35	34	NV	NV	NV	28%

BLOCK B BENCH WORK

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	13	13	5	11	5	7	5	6	5	15	NV	NV	NV	9%

Task 4 Performs hand processes.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	70	60	59	70	75	50	60	60	75	NV	NV	NV	63%

Task 5 Refurbishes components.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	30	40	41	30	25	50	40	40	25	NV	NV	NV	37%

BLOCK C DRILL PRESSES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	8	5	10	11	5	6	5	8	10	10	NV	NV	NV	8%

Task 6 Sets up drill presses.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	60	55	54	40	50	50	48	40	60	NV	NV	NV	51%

Task 7 Operates drill presses

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	40	45	46	60	50	50	52	60	40	NV	NV	NV	49%

BLOCK D CONVENTIONAL LATHES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	25	25	25	24	15	24	30	25	20	20	NV	NV	NV	23%

Task 8 Sets up conventional lathes.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	40	45	51	40	47	60	39	40	40	NV	NV	NV	45%

Task 9 Operates conventional lathes.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	60	55	49	60	53	40	61	60	60	NV	NV	NV	55%

BLOCK E CONVENTIONAL MILLING MACHINES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	25	25	25	24	20	24	30	25	20	20	NV	NV	NV	24%

Task 10 Sets up conventional milling machines.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	50	45	51	40	55	60	51	40	50	NV	NV	NV	49%

Task 11 Operates conventional milling machines.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	50	55	49	60	45	40	49	60	50	NV	NV	NV	51%

BLOCK F POWER SAWS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	4	5	7	5	5	5	5	10	5	NV	NV	NV	6%

Task 12 Sets up power saws.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	60	45	49	40	67	60	57	50	60	NV	NV	NV	54%

Task 13 Operates power saws.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	40	55	51	60	33	40	43	50	40	NV	NV	NV	46%

BLOCK G PRECISION GRINDING MACHINES

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	5	5	10	9	15	8	5	8	10	5	NV	NV	NV	8%

Task 14 Sets up precision grinding machines.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	60	50	51	40	62	60	36	55	60	NV	NV	NV	52%

Task 15 Operates precision grinding machines.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	40	50	49	60	38	40	64	45	40	NV	NV	NV	48%

BLOCK H COMPUTER NUMERICAL CONTROL (CNC) MACHINE-TOOLS

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	National Average
%	7	15	10	5	20	17	5	16	20	20	NV	NV	NV	13%

Task 16 Performs basic CNC programming.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	50	27	35	55	40	35	20	43	40	40	NV	NV	NV	38%

Task 17 Sets up CNC machine-tools.

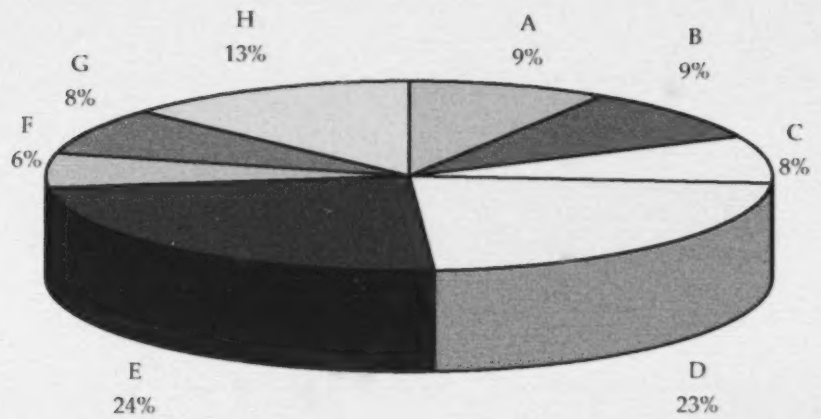
	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	30	45	30	25	25	40	40	34	30	30	NV	NV	NV	33%

Task 18 Operates CNC machine-tools.

	NL	NS	PE	NB	QC	ON	MB	SK	AB	BC	NT	YT	NU	
%	20	28	35	20	35	25	40	23	30	30	NV	NV	NV	29%

APPENDIX E

PIE CHART*



TITLES OF BLOCKS

BLOCK A	Common Occupational Skills	BLOCK E	Conventional Milling Machines
BLOCK B	Bench Work	BLOCK F	Power Saws
BLOCK C	Drill Presses	BLOCK G	Precision Grinding Machines
BLOCK D	Conventional Lathes	BLOCK H	Computer Numerical Control (CNC) Machine-Tools

*Average percentage of the total number of questions on an interprovincial examination, assigned to assess each block of the analysis, as derived from the collective input from workers within the occupation from all areas of Canada. Interprovincial examinations typically have from 100 to 150 multiple-choice questions.

APPENDIX F

TASK PROFILE CHART — Machinist

BLOCKS	TASKS	SUB-TASKS				
A - COMMON OCCUPATIONAL SKILLS	1. Organizes work.	1.01 Interprets documentation.	1.02 Plans sequence of operations.	1.03 Maintains safe work environment.	1.04 Uses personal protective equipment (PPE) and safety equipment.	1.05 Uses hoisting, lifting and rigging equipment.
	2. Processes workpiece material.	2.01 Selects workpiece material.	2.02 Performs layout.	2.03 Marks workpiece for identification.	2.04 Performs basic heat treatment.	2.05 Tests workpiece materials.
		2.06 Deburrs workpiece.	2.07 Sketches parts.			
	3. Maintains machines and tooling.	3.01 Cleans machines.	3.02 Lubricates machines.	3.03 Sharpens tooling.	3.04 Applies cutting fluids and coolants.	3.05 Trouble-shoots equipment.
		3.06 Maintains machine alignment.	3.07 Maintains inspection equipment.			
B - BENCH WORK	4. Performs hand processes.	4.01 Files workpiece.	4.02 Saws workpiece.	4.03 Performs hole-making operations.	4.04 Performs threading operations.	4.05 Installs thread inserts.
		4.06 Broaches workpiece.	4.07 Performs pressing operations.	4.08 Bends workpiece.	4.09 Finishes workpiece.	
	5. Refurbishes components.	5.01 Disassembles components.	5.02 Analyzes components.	5.03 Assembles components.		

BLOCKS	TASKS	SUB-TASKS				
C - DRILL PRESSES	6. Sets up drill presses.	6.01 Selects drill press types.	6.02 Plans drill press sequence.	6.03 Selects drill press speeds and feeds.	6.04 Sets up jigs, fixtures and work holding devices for drill presses.	6.05 Sets up tooling for drill presses.
	7. Operates drill presses.	7.01 Drills holes using a drill press.	7.02 Cuts countersinks, counterbores, chamfers and spot faces using a drill press.	7.03 Performs tapping using a drill press.	7.04 Finishes holes using a drill press.	
D - CONVENTIONAL LATHES	8. Sets up conventional lathes.	8.01 Selects conventional lathe types.	8.02 Plans sequence of operations for conventional lathes.	8.03 Sets up work holding devices for conventional lathes.	8.04 Sets up tooling for conventional lathes.	8.05 Sets up conventional lathe accessories.
		8.06 Sets up workpiece on conventional lathe.	8.07 Selects conventional lathe speeds and feeds.	8.08 Sets up eccentrics on conventional lathes.		
	9. Operates conventional lathes.	9.01 Turns external surfaces using a conventional lathe.	9.02 Bores holes using a conventional lathe.	9.03 Faces surfaces using a conventional lathe.	9.04 Turns tapers on a conventional lathe.	9.05 Knurls using a conventional lathe.
		9.06 Parts off workpiece using a conventional lathe.	9.07 Drills using a conventional lathe.	9.08 Reams holes using a conventional lathe.	9.09 Cuts grooves using a conventional lathe.	9.10 Cuts threads using a conventional lathe.
E - CONVENTIONAL MILLING MACHINES	10. Sets up conventional milling machines.	10.01 Selects conventional milling machine types.	10.02 Plans milling sequence.	10.03 Sets up work holding devices for conventional milling machines.	10.04 Sets up tooling for conventional milling machines.	10.05 Sets up milling accessories.

BLOCKS	TASKS	SUB-TASKS				
		10.06 Sets up workpiece on a conventional milling machine.	10.07 Selects conventional milling machine speeds and feeds.			
	11. Operates conventional milling machines.	11.01 Mills surfaces using a conventional milling machine.	11.02 Mills profiles and pockets using a conventional milling machine.	11.03 Mills slots, grooves and keyways using a conventional milling machine.	11.04 Cuts gears and splines using a conventional milling machine.	11.05 Drills holes using a conventional milling machine.
		11.06 Reams holes using a conventional milling machine.	11.07 Cuts countersinks, counterbores, chamfers and spot faces using a conventional milling machine.	11.08 Performs tapping using a conventional milling machine.	11.09 Bores holes using a conventional milling machine.	
F - POWER SAWS	12. Sets up power saws.	12.01 Selects power saw types.	12.02 Selects saw blades.	12.03 Installs saw blades.	12.04 Selects power saw speeds and feeds.	12.05 Makes power saw adjustments.
		12.06 Sets up workpiece on power saw.				
	13. Operates power saws.	13.01 Saws straight and angle cuts.	13.02 Cuts irregular shapes.			
G - PRECISION GRINDING MACHINES	14. Sets up precision grinding machines.	14.01 Selects precision grinding machine types.	14.02 Plans grinding sequence.	14.03 Sets up work holding devices for precision grinding machines.	14.04 Mounts grinding wheel.	14.05 Sets up grinding accessories.
		14.06 Sets up workpiece on precision grinding machines.	14.07 Selects precision grinding machine speeds and feeds.			

BLOCKS	TASKS	SUB-TASKS				
	15. Operates precision grinding machines.	15.01 Grinds flat surfaces using a surface grinder.	15.02 Grinds profiles.	15.03 Grinds internal and external cylindrical and tapered surfaces.	15.04 Grinds tools and cutters.	15.05 Finishes holes using a honing machine.
H - COMPUTER NUMERICAL CONTROL (CNC) MACHINE-TOOLS	16. Performs basic CNC programming.	16.01 Reviews process documentation.	16.02 Calculates coordinates for tool path.	16.03 Creates basic program.	16.04 Inputs program into control memory.	16.05 Optimizes program.
	17. Sets up CNC machine-tools.	17.01 Selects tooling and tool holders for CNC machine-tools.	17.02 Sets up tooling and tool holders for CNC machine-tools.	17.03 Sets up workpiece on CNC machine-tool.	17.04 Establishes work datum.	17.05 Verifies program.
	18. Operates CNC machine-tools.	18.01 Adjusts offsets.	18.02 Monitors machining processes.	18.03 Interrupts program cycle.	18.04 Restarts program cycle.	